S Afr Optom 2008 **67**(3) 118-124

Perceived effects of coloured overlays on reading material in persons with albinism

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Received 3 June 2008; revised version accepted 30 September 2008

Abstract

Persons with albinism often complain of glare when reading. They may therefore benefit from coloured filter overlays just as they benefit from tinted lenses. The purpose of this study was to assess the effect of coloured overlays on print perception in persons with oculocutaneous albinism (OCA). Fifty subjects were included in this study, their ages ranged from 12 to 31 years with a mean of 16.12 years (SD = ± 4.56 years). Following refraction and subsequent compensation for refractive errors, subjective perception of print was examined with the subject looking at the Wilkins® reading rate test chart with and without colored filter overlay/s. The subjects were asked to respond to questions previously used in a questionnaire by Wilkins (2001). The percentage frequencies of positive (beneficial) responses were used to decide whether or not a particular overlay would enhance reading performance. McNemar's test was used to establish significant differences between responses to questions without and with overlays. All single overlays gave greater percentages of positive responses (92.0-97.2%) than without overlay (85.2%). The single overlay that provided the highest positive responses was blue (97.2%) and the least was purple (92.0%). All double overlays, except grey/grey (82.0%) gave greater positive responses than without overlay (85.2%). Aqua/blue gave the greatest positive responses (possible benefits) (97.2%), followed by rose/rose (96.8%). Comparing the responses without overlay with single and double overlays, the difference in responses to the five questions was only significant ($p < 0.05$) with regard to brightness of the surface. The results suggest that overlays provided a more glare-free reading surface than without an overlay. It was, therefore concluded that the best advantage of the coloured overlays was in glare reduction. Although this study showed that there were more subjects who preferred single blue and aqua/blue double overlays, inter-subject preference for overlays varied, therefore the best overlay should be established for every patient for whom overlay is to be prescribed.

Key words: Oculocutaneous albinism, Coloured overlays, Glare, Filter overlays and Reading.

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Introduction

Albinism is a congenitally inherited condition of hypomelanosis involving the pigmented structures of the body, namely the eyes, skin and hair. In ocular albinism (OA) only the eyes are affected, whereas in oculocutaneous albinism (OCA) there is a lack of pigmentation in the eyes, hair and skin[1]. Oculocutaneous albinism type 2 (OCA2) is the predominant type of OCA found throughout the sub-Saharan Africa; with a classic phenotype among the black population being sandy to yellow hair, pale chalky coloured skin and blue to hazel eyes[2]. In Zimbabwe, a prevalence of 1 in 4182 was reported among school children[3], with a higher frequency of 1 in 1000 among the isolated Tonga people[4]. In South Africa, in Soweto, south west of Johannesburg, the frequency was 1 in 3900 and was partly attributed to the practice of consanguineous marriages among certain ethnic groups[5]. The frequency of OCA2 in the rural area of the Limpopo Province of South Africa, where this study was conducted, is particularly high, at 1 in 1500 neonates[6].

Tinted lenses are used by eye care practitioners to assist people with low vision to maximize the use of residual vision, improve visual function, control glare and improve orientation and mobility skills[7]. They are often prescribed to people with various ocular diseases including age-related macular degeneration (AMD), retinitis pigmentosa (RP), cataract, diabetic retinopathy, cone dystrophy and oculocutaneous albinism[7]. The ability of yellow filter lenses to improve vision has been documented[8-13]. Other colours such as orange, red and grey also have the potential to enhance vision[9, 10]. Due to hypopigmentation of the iris and the retinal pigment epithelium, high level of sensitivity to glare is a major symptom among persons with albinism. Coloured ophthalmic filters are often prescribed for people with albinism to reduce ocular discomfort, enhance visual performance or both[14]. Dark amber lenses significantly decrease the light intensity and are able to diminish all visual adverse effects in people with albinism[15]. The ability of coloured short wavelength light-absorbing filters to improved contrast sensitivity among subjects has been attributed to reduction in intraocular light scatter[8, 16].

It has been recognized that coloured plastic overlays improve reading fluency and speed in certain individuals with reading difficulties[17-28]. In addition to improving reading fluency, they also reduce symptoms of asthenopia[13]. The intuitive colored plastic overlays® developed by Wilkins[18] consist of 10 A5–sized plastic sheets with the following colours: rose, pink, purple, aqua, blue, lime-green, mint-green, yellow, orange and grey. They are distributed by IOO Marketing Ltd, London, UK. The colours are based on the CIE 1976 hue saturated value (HSV) colour space, where hue angle *huv* and saturation *suv* are used to specify colours in an orderly and scientific manner[18]. The hue angle between neighboring colours averages 40 degrees with a standard deviation (SD) of 7.7 degrees, the saturation averages 0.52 (SD = 0.19)[18].

In view of extreme glare sensitivity experienced by individuals with albinism, we felt that coloured filter overlays could provide a significant glare relief to them. The purpose of this study, therefore was to investigate the possible benefits of various coloured filter overlays on reading in persons with oculocutaneous albinism, which hitherto has not been investigated.

Methods

The proposal to conduct this study was approved by the Research and Ethics Committees of the University of Limpopo, South Africa. Fifty subjects (28 males and 22 females) with oculocutaneous albinism were included in this study. Their ages ranged from 12 to 31 years with a mean of 16.12 years (SD = ± 4.56 years). The subjects were university students, high school and primary school learners. The high school and primary school participants were boarding learners at the special schools for the disabled children in the Limpopo Province. A detailed explanation of the research procedure was presented to each subject. In addition, the participants were assured that no discomfort or injury could result from the procedure. All the university subjects who participated in the study signed a written consent form and the principals of the primary and high school subjects signed the form on behalf of the parents of the children.

The Wilkins reading rate test chart[24] and the intuitive coloured filter overlays[18] were used in this study. Following refractive error measurement and refractive compensation, each subject was seated at a table that was illuminated by the general overhead room source provided by fluorescent lamps. The illumination levels were not measured because light meter was not available; however, approximately the same level of illumination was used for each subject for the procedures with and without overlay/s. Each subject was asked to look at words on the Wilkins

reading rate test chart without coloured overlay, and subsequently through each single overlay, followed by double overlays. They were then asked to respond to the questions previously asked by Wilkins on their symptoms questionnaire[24].

The colours of overlays used in the study and their percentages transmission values were mint green (85%), pink (78%), aqua (81%), blue (74%), rose (78%), lime-green (86%), purple (67%), orange (83%), grey (71%), yellow (93%)18. These single overlays were combined to form double overlays as pink/pink, aqua/blue, orange/yellow, rose/rose, yellow/lime-green, pink/rose, mint-green/aqua, rose/orange, blue/blue, yellow/yellow, mint/mint, orange/orange, lime-green/mint-green, purple/pink, lime-green/lime-green, blue/purple, aqua/aqua, purple/purple and grey/grey. The overlays were randomly presented to the subjects during the study.

With the subjects looking at the rate of reading test chart with or without the overlays, the following questions were asked: 1. "Do the letters appear ***still*** or *moving*?" 2. "Are the letters appearing ***clear*** or *blurred*?" 3. "Are the words t*oo close to one another* or ***far enough apart***?" 4. "Is the page *too bright*, *not bright enough* or ***just about right***"? 5. "Does the page *hurt your eyes to look at* or ***it is just about right***?" In the analysis of responses, those in bold were referred to as positive, and those in italics were considered to be negative. The descriptive statistics of the Statistical Package for Social Science (SPSS) software and McNemar's test were used to analyze the data. In order to rank the overlays according to their benefits, the positive responses for each overlay were added together to obtain the total number of positive responses for each overlay. Similarly, the negative responses were added together to obtain the value of negative for each overlay. The overlay with the highest positive responses was considered to be of greatest benefits for the subjects. Significant difference between responses to the questions asked without overlay and with the best single and double overlay was examined with the McNemar's test.

Results

The percentage of positive responses without overlay was 85.2%. The percentage frequency of the positive responses for all the single overlays was better than without overlays (see Tables 1 and 2 and Figure 1).

Table 1. Showing the Wilkinson[18] questions 1-5 and the positive responses with the single overlays for all subjects (N= 50). Blue overlay provided the highest number of positive responses and purple has the least. The highest score per question would be 50 and 250 for the five questions in this forced-choice procedure

Overlay colours	Questions 1- 5 and positive responses					
	Still	*Clear*	*Far enough*	*Just about right*	*Does not hurt*	Total
Blue	50	48	49	47	49	243
Mint green	50	46	49	45	49	239
Lime green	49	49	49	43	48	238
Rose	50	47	48	43	50	238
Orange	49	47	50	44	47	237
Pink	49	45	47	45	47	233
Grey	49	49	49	36	49	232
Yellow	49	46	47	41	48	231
Aqua	48	45	48	41	48	230
Purple	47	47	48	40	48	230
Range	47-50	45-49	47-50	36-47	47-50	230-243
Mean	49	46.9	48.4	42.5	48.3	235.1
SD	0.94	1.45	0.97	3.14	0.95	4.48
No Overlay	48	45	45	29	46	213

Table 2. The total and percentage, minimum, maximum, mean and standard deviation of the positive responses (N=50) for the single overlays, for the five questions asked. The values are presented in order of decreasing total frequency.

Overlay colours	Questions 1- 5 and positive responses				
	Total (%)	MIN	MAX	MEAN	SD
Blue	243 (97.2)	47	50	48.6	1.12
Lime green	239 (95.6)	45	50	47.8	2.17
Mint green	238 (95.2)	43	49	4706	2.61
Rose	238 (95.2)	43	50	47.6	2.90
Orange	237 (94.8)	44	50	47.4	2.30
Pink	233 (93.2)	45	49	46.6	1.67
Grey	232 (92.8)	36	49	46.4	5.81
Yellow	231 (92.4)	41	49	46.2	3.11
Aqua	230 (92.0)	41	48	46.0	3.08
Purple	230 (92.0)	40	48	46.0	3.39
No Overlay	213 (85.2)	29	48	42.6	7.70

The single blue overlay yielded the highest positive responses (97.2%), followed by mint green with 95.6%. Purple yielded the lowest percentage, (92.0%). The percentage of negative responses for 'without overlay' was 14.8%. The single overlay with the least negative response was blue (2.8%) and those with the highest value (8% each) were purple and aqua.

Double overlays were also found to yield greater positive responses than without overlays (see Tables 3, 4 and Figure 1). However, the difference was significant only in the brightness of the reading surface.

Table 3. Showing the Wilkins[18] questions 1-5 and the positive responses with double overlays for all subjects (N= 50). Aqua/blue overlay provided the highest number of positive responses and grey/grey provided the least number of positive responses. The highest score per question would be 50 and 250 for the five questions in this forced-choice procedure.

Overlay colours	Questions 1- 5 and positive responses					
	Still	*Clear*	*Far enough*	*Just about right*	*Does not hurt*	Total
Aqua/blue	50	46	50	50	49	243
Rose/rose	49	49	50	50	48	242
M.gre/m. green	50	47	50	50	48	241
Pink/pink	49	48	50	50	49	240
L/green/l. green	50	49	50	50	48	240
Rose/orange	49	49	49	49	48	239
M.green/aqua	49	47	48	48	49	239
L.gre/m. green	48	47	50	50	48	236
Pink/rose	46	46	49	49	48	236
Orange/orange	48	45	50	50	48	234
Blue/blue	49	48	49	49	48	233
Aqua/aqua	47	47	50	50	47	232
Orange/yellow	47	43	50	50	49	231
Yellow/l. green	48	44	50	50	46	227
Purple/pink	50	47	49	499	47	226
Blue/purple	50	47	50	50	47	224
Yellow/yellow	47	39	50	50	45	217
Purple/purple	50	47	48	48	45	215
Grey/grey	49	47	48	48	48	205
Range	46-50	39-49	48-50	48-50	45-49	205-243
Mean	48.7	46.4	49.5	49.5	47.6	231.6
SD	1.25	2.39	0.77	0.77	1.21	10.36
No overlay	48	45	45	45	46	213

Table 4. The total and percentage, minimum, maximum, mean and standard deviation of the positive responses by the 50 subjects for the double overlays, for the five questions asked. The values are presented in order of decreasing total frequency.

Overlay colours	Frequencies of positive responses				
	Total (%)	*Min*	*Max*	*Mean*	*SD*
Aqua/blue	243 (97.2)	46	50	48.6	1.67
Rose/rose	242 (96.8)	46	50	48.4	1.52
M.gre/m. green	241 (96.4)	46	50	48.2	1.79
Pink/pink	240 (96.0)	44	50	48.0	2.35
L/greem/l. green	240 (96.0)	43	50	48.0	2.92
Rose/orange	239 (95.6)	44	49	47.8	2.17
M.green/aqua	239 (95.6)	46	49	47.8	1.30
L.gre/m. green	236 (94.4)	43	50	47.2	2.59
Pink/rose	236 (94.4)	46	49	47.5	1.30
Orange/orange	234 (93.6)	43	50	46.8	2.77
Blue/blue	233 (93.2)	39	49	46.6	4.28
Aqua/aqua	232 (92.8)	41	50	46.4	3.29
Orange/yellow	231 (92.4)	42	50	46.2	3.56
Yellow/l. green	227 (90.8)	39	50	15.2	4.22
Purple/pink	226 (90.4)	33	50	44.8	6.94
Blue/purple	224 (89.6)	30	50	43.4	8.41
Yellow/yellow	217 (86.8)	36	40	43.0	5.77
Purple/purple	215 (86.0)	25	50	41.0	10.2
No overlay	213 (85.2)	29	48	42.6	7.7
Grey/grey	205 (82.0)	13	49	42.6	15.7

The highest percentage of positive responses was with aqua/blue) (97.2%) followed by 96.8 % for rose/rose (Tables 3 and 4). Grey/grey (82.0 %) was the only double overlay with less value than without an overlay. The double overlay with the least negative response was aqua/blue (2.8%) and that with the highest value (18%) was grey/grey. Figure 1 shows the frequency of positive responses for the best double overlay (aqua/blue), best single overlay (blue) and no overlay, for the five questions asked. The responses for the single and double overlays were higher than without overlay in all cases.

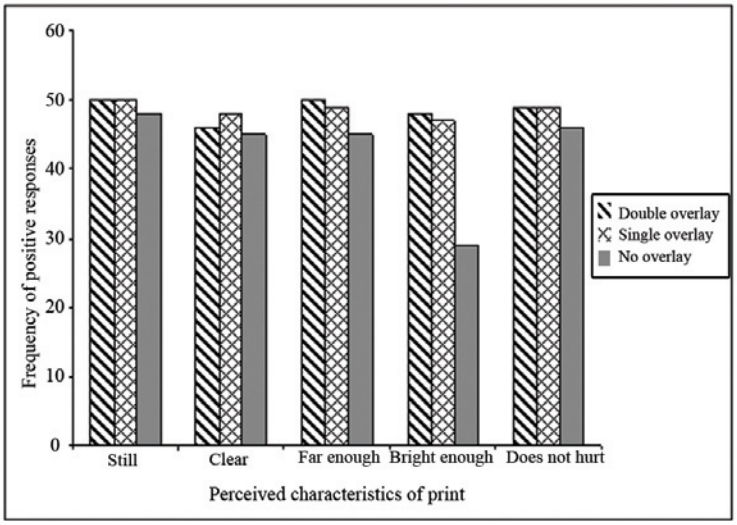

Figure 1. Showing the frequency of the responses to each question through the best double overlays (Aqua/blue), best single overlay (blue) and no overlay. Both best overlays yielded greater positive responses for all the five questions than without an overlay.

There was a significant difference in the responses between the perceived print characteristics through the overlays compared to without overlays with regard to brightness of the page ($p<0.05$). Most of the subjects found the page without overlay to be too bright. The differences found with the other questions, however, were not statistically significant for with and without overlays.

Discussion and Conclusion

Coloured lenses and overlays are known to improve quality of vision[7-28]. Even children with normal vision could benefit from reading with overlays. Tyrell *et al*.[20] found that more children with normal vision reported symptoms of visual discomfort when reading without overlays than when reading with overlays. Our results show that individuals with albinism will benefit from overlays because the subjects reported more positive responses (Tables 1-4 and Figure 1), hence less negative responses when viewing print with overlays compared to when viewing without overlays. It is assumed that all the single overlays and most doubles, except a few ones such as grey/grey would provide some benefits for reading to individuals with albinism, especially in terms of visual comfort. Although positive responses to all single and all double overlays except grey/grey were generally higher than without overlay, the McNemar's test which was used to establish the differences in responses without and with the best single and double overlays showed that the differences were only significant ($p > 0.05$) with regard to the brightness of the surface. This suggests that the best benefit of the overlay was in the reduction of glare effect for the subject. This may explain the subjective comments by the subjects that the overlays were more comfortable than reading without overlay.

There are two characteristics of the coloured filter overlays which may influence vision; these are the colour (hue) and the transmission value. It has been reported that short wavelength-absorbing lenses such as yellow improve print contrast, therefore improving the print appearance by reducing intraocular light scattering[8, 16]. In the present study, the colours and their transmission values which have the potential to provide the greatest benefits for reading among the single overlays were blue (74%), mint green (85%) and lime green (86%). The overlay preference may presumably be attributed to both the transmission values and colours of the overlays, as there was no consistent relationship between overlay preference and transmission values. The obvious finding, however, was that vision with overlays was perceived to be better than without overlays.

Among the double overlays, aqua/blue provided the greatest positive responses, suggesting greatest potential for benefits. Again, this could be attributed to both hue and transmission percentages of the overlays. The grey/grey combination was the only overlay that was considered not to be of benefit to the subjects, as the percentage of positive responses (benefits) (82.0%) was lower than without overlay (85.2%). The poor responses with the grey/grey overlays may be attributed to the dim nature of the combined overlays. This may relate to the low transmission value (71%); the combination of which may yield even lower transmission value. This suggests that, although individuals with albinism prefer dim surfaces when reading, there is an optimal transmission percentages preferred by these people and when the surface brightness becomes too low, it is detrimental to their vision.

It is concluded that coloured overlays will be of benefit for reading in persons with oculocutaneous albinism. This is in agreement with previous findings that coloured overlays can reduce symptoms of visual stress and improve reading speed and therefore, enhance reading performance[18-28]. However, it should be noted that in the case of individuals with albinism, the effect is more of preventing glare rather than having effects on the clearness or stability of the prints. This implied that although filter overlays may have various benefits for individual with albinism, the main benefit is in reducing glare, hence providing comfort. It is recommended that the test for coloured filter overlays for reading should be part of routine eye examination for patients with albinism. The overlay may reduce the glare experienced from the material being read. In view of the variability in the overlay preference, Optometrists should determine and prescribe the appropriate overlay for each person with albinism. As most children with albinism attend special education schools. It is further recommended that, the Department of Education should consider supplying coloured overlays for children with albinism in those schools.

Acknowledgement

Assistance of Mrs. Fikile Nkwanyana in data analysis is acknowledged. Thanks to all subjects who participated in the study.

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